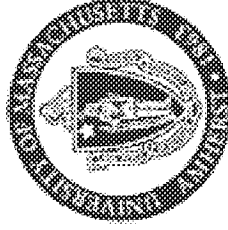


Laser Safety



Lab Safety Coordinators Meeting

January 23, 2013

Laser Safety Training

Properties of lasers that make them dangerous

- Monochromatic
- Directional
- Coherent light
 - Light waves stack and are in phase with one another
 - Gives laser light its power
- Low divergence
- High irradiance
 - High radiant power in a very small area is the single most important property of lasers that can lead to injuries.

Laser Safety Training

Changes in Laser Classification System

Old

Class 1

Class 2

Class 2A

- FDA only: max viewing 1000 sec.

Class 3A

- FDA only: for visible wavelengths only. No collecting optics.

Class 3B

Class 4

New

Class 1

- Eye safe with optical aids.

Class 1M

- Eye safe without optical aids.

Class 2

- Eye safe for momentary viewing.

Class 2M

- Eye safe for momentary viewing w/o optical aids.

Class 3R

- Harmonizes ANSI & FDA hazard definitions with IEC.
Potential hazard if eye appropriately focused and stable.

Class 3B

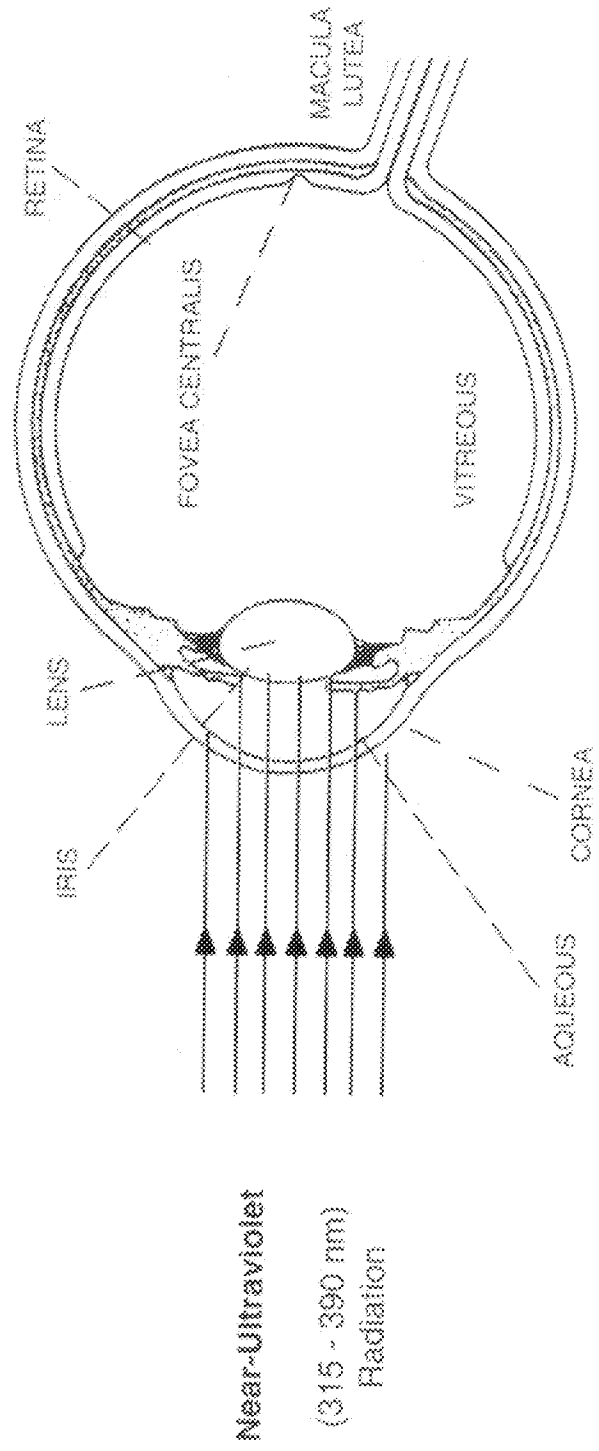
Class 4

Laser Safety Training

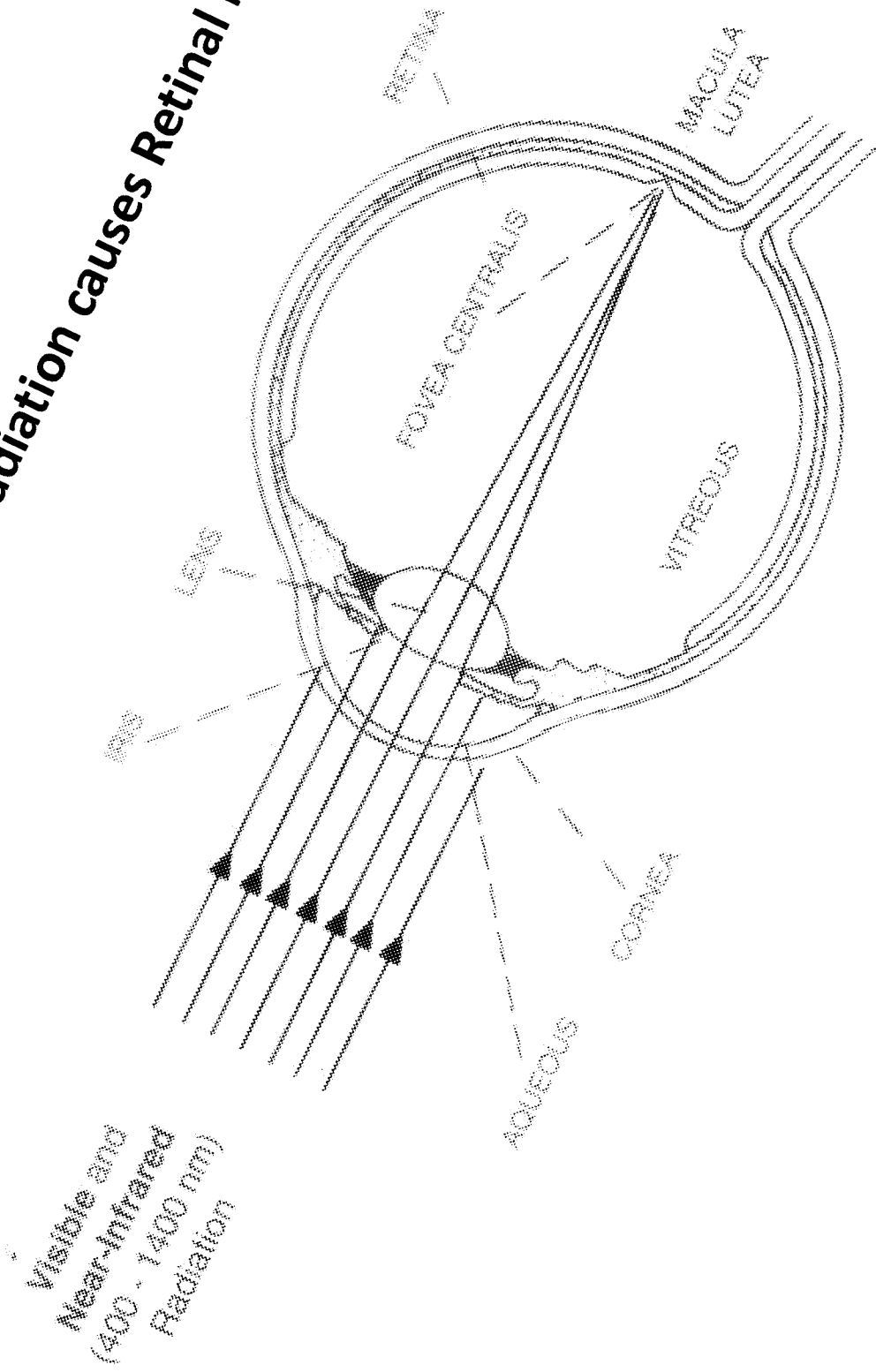
Laser type	Wavelength (nanometers)	Laser type	Wavelength (nanometers)
Argon fluoride (Excimer-UV)	193	Helium neon (yellow)	594
Krypton chloride (Excimer-UV)	222	Helium neon (orange)	610
Krypton fluoride (Excimer-UV)	248	Gold vapor (red)	627
Xenon chloride (Excimer-UV)	308	Helium neon (red)	633
Xenon fluoride (Excimer-UV)	351	Krypton (red)	647
Helium cadmium (UV)	325	Rhodamine 6G dye (tunable)	570 - 650
Nitrogen (UV)	337	Ruby (CrAlO ₃) (red)	694
Helium cadmium (violet)	441	Gallium arsenide (diode-NIR)	0840
Krypton (blue)	476	Nd:YAG (NIR)	1,064
Argon (green)	488	Helium neon (NIR)	1,150
Copper vapor (green)	510	Erbium (NIR)	1,504
Argon (green)	514	Helium neon (NIR)	3,390
Krypton (green)	528	Hydrogen fluoride (NIR)	2,700
Frequency doubled Nd YAG (green)	532	Carbon dioxide (FIR)	9,600
Helium neon (green)	543	Carbon dioxide (FIR)	10,600
Krypton (yellow)	568		
Copper vapor (yellow)	570		
Key: UV = ultraviolet (0.200-0.400 nm) NIR = near infrared (700- 3400 nm) FIR = far infrared (3400 nm or greater)			

Laser Safety Training

Near Ultraviolet – Can contribute to certain forms of cataracts
Xenon Chloride Excimer: Instant cataract, 308 nm pulsed laser



Laser Safety Training
Visible and Near-Infrared Radiation causes Retinal burn



Laser Safety Training

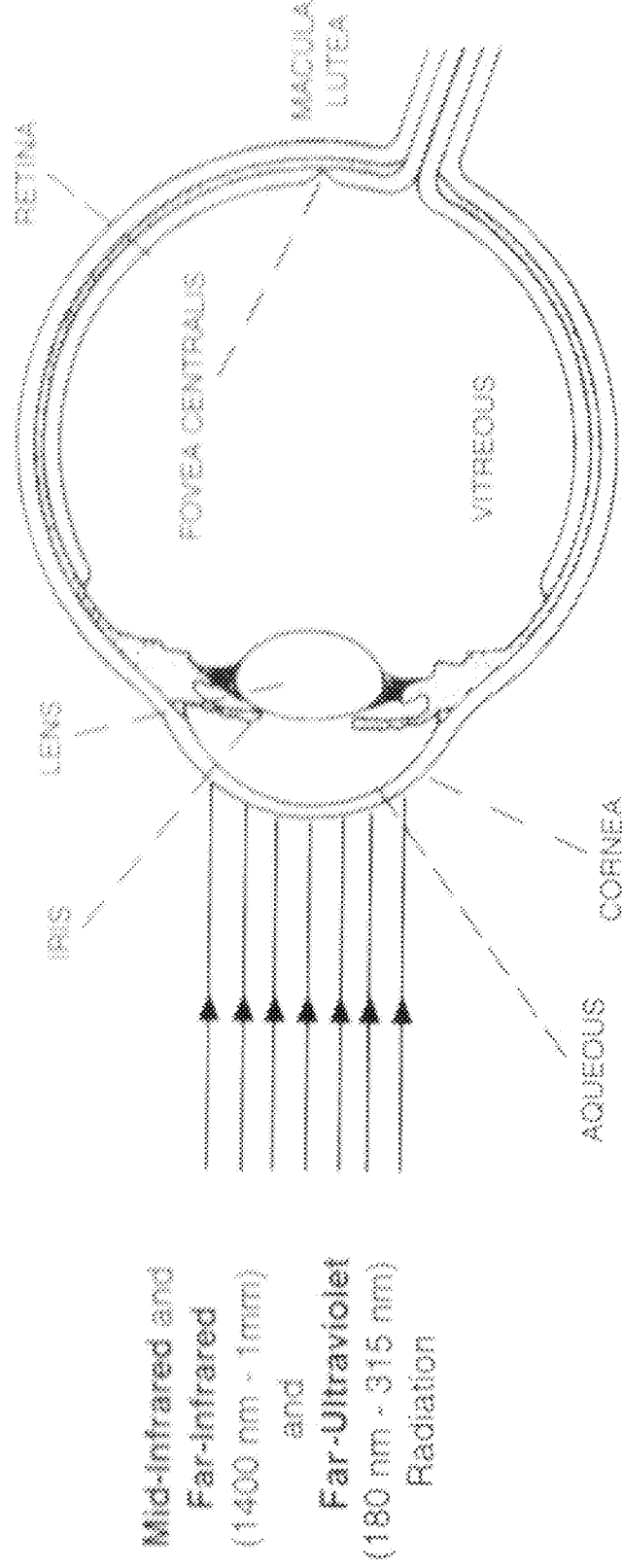
Mid and Far Infrared - causes damage to the cornea due to high temperature in tears and tissue water.

- Used in surgery to vaporize tissue.

- CO₂ : 10,600nm, cauterize; NdYAG: 1,064, ablate corneal bursa post cataract

Mid Ultraviolet – causes photokeratitis (welders flash)

- Used in LASIK eye surgery. ArF Excimer: 193.3 nm pulsed laser



Laser Safety Training

Eyewear and Shielding

Make sure you choose the proper eyewear for the laser that is being used in the lab.

Proper laser safety eyewear is determined by frequency of laser beam (color and/or invisible) and optical density of lens

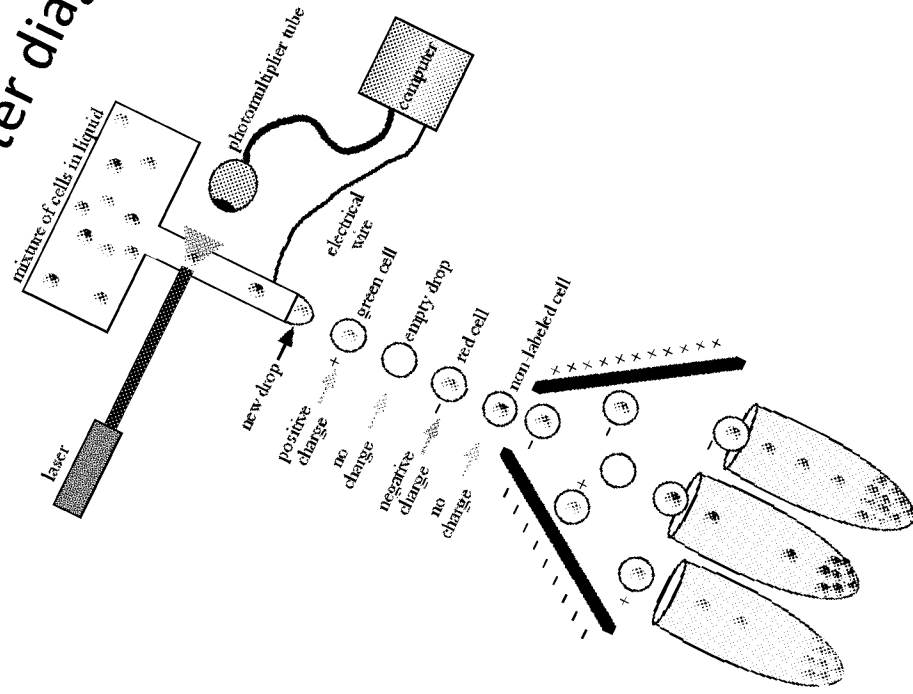
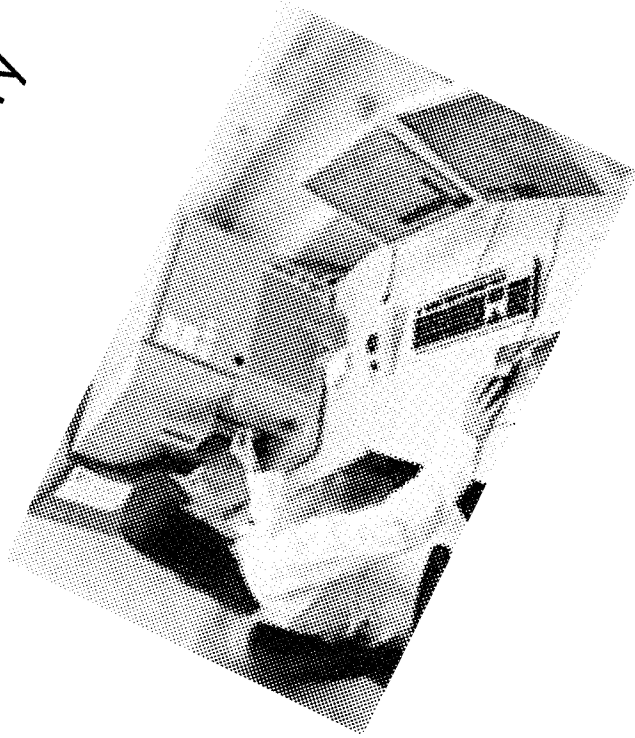
OD2 = 10^2 = 100x reduction of light intensity

OD5 = 10^5 = 100,000x reduction of light intensity

Flow cytometry

Laser Safety Training

FACS cell sorter diagram



Laser Safety Training

Eyewear and Shielding

Make sure you choose the proper eyewear for the laser that is being used in the lab.

For the CO₂ (10,200 – 10,800 nm) laser that is used in the Jamieson cutting machine, clear plastic safety glasses will stop the refracted laser beam from hitting the eye

- plastic absorbs high energy laser, glass eyewear does NOT!
- shatterproof (Z-87.1 rated)

Clear plastic which is at least 1/4 inch thick is an effective shield against stray beams from a CO₂ laser.

- in laser machine shops, there will be clear, plastic strips hanging from the ceiling that surround the a non-enclosed cutting laser
- not unlike the clear, plastic strips at a car wash entrance

Laser Safety Training

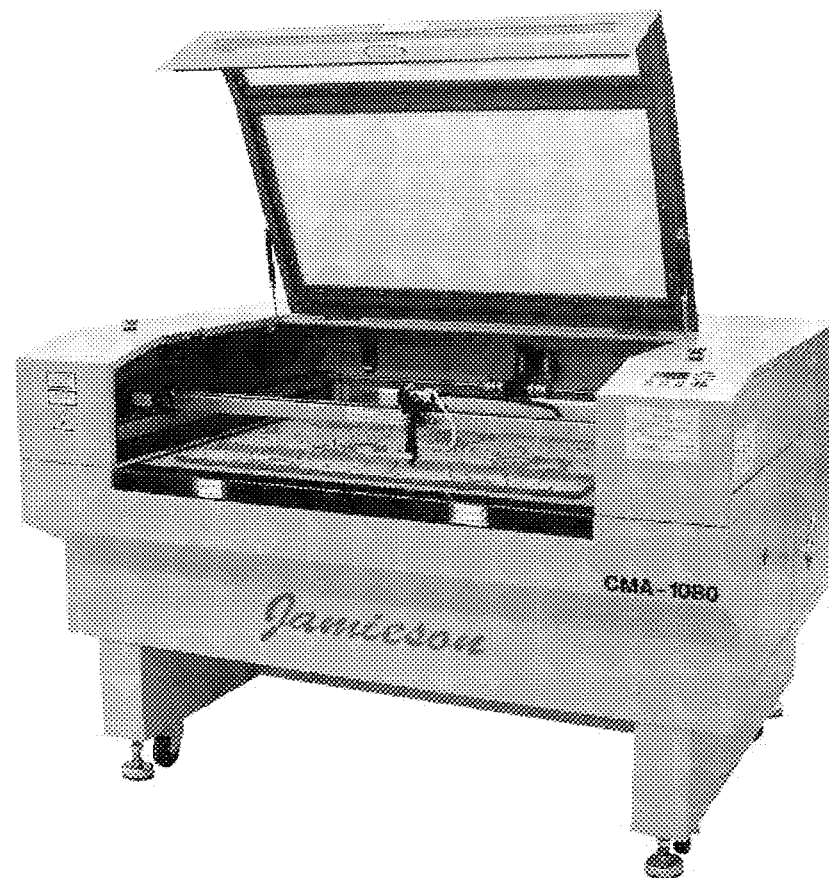
Eyewear and Shielding

Jameison CO₂ Laser Cutting System

- **Main Features:**
- Lowest priced machines in the industry
- State-of-the-art engraving and cutting software supporting 10 commonly used graphic formats
- USB port interface
- 32M of program storage
- Analog laser control to reduce power around tight curves
- Coated ZnSe meniscus focusing lenses, choice of 2.0", 2.5" or 3.3" focal lengths
- Focusing is simple and takes only seconds
- All models feature a red dot alignment pointer, helping you to properly position your work under the laser head
- **Rear door opening and feed-through design allows the use of roll material and unlimited sheet length**
- The work rests on a down-draft table connected to the exhaust fan; this pulls fumes and debris away from the work piece; the resulting vacuum is strong enough to straighten and flatten thin materials against the work table for cutting and engraving in perfect focus
- Water cooler for the CO₂ laser, exhaust fan, and air assist compressor are all included in the price, as are personalized training, our two-year parts warrantee and one-year laser tube and optics warrantee

Laser Safety Training

Jameison CO₂ Laser Cutting System



Laser Safety Training

Jameison CO₂ Laser Cutting System

In operation

<http://www.youtube.com/watch?v=1q69Npv5Yl4>

Laser Safety Training

Reflections

- Be careful with reflective objects
 - Jewelry
 - Watches, rings, necklaces
 - High gloss nail polish or paints
 - Metal containers
 - highly polished bare metal
 - shiny finish
 - Objects with a highly reflective finish
 - Single-edged razor blades
 - Tools (screw drivers)

Laser Safety Training

Laser Window Failure

Hazardous Materials Exposure

Orange, MA

<http://www.wwlp.com/dpp/news/local/franklin/hazardous-materials-situation-in-franklin-county>

Laser Safety Training

Laser generated aerosols

Care must be taken to prevent the inhalation of aerosols when using a laser to heat or burn any biological sample, metal, wood, plastic or other material.

- nanoparticle formation

Example: Particle board and medium density fiberboard (MDF) are created in the same way, though with different types of wood trimmings. Particle board is made from ground-down wood particles such as sawdust. MDF is made from steam-separated fibers, which are dried and then mixed with a binder --- a resin that holds the wood debris together. This waxy resin is usually a synthetic compound called urea formaldehyde.

Proper ventilation (snorkle, vented enclosure) must be used when using a laser cutter to avoid excessive inhalation of smoke or aerosols produced during the cutting procedure.

Laser Safety Training

Laser generated aerosols

Care must be taken to prevent the inhalation of aerosols when using a laser to heat or burn any biological sample, metal, wood, plastic or other material.

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Laser Safety Training

Laser generated aerosols

<u>Material</u>	<u>Cutting</u>	<u>Engraving</u>
Acrylic	X	X
Anodized Aluminum		X
Bare Metal*		X
Brass*		X
Brick		X
Cardboard	X	X
Ceramic		X
Coated Metals		X
Corian		X
Cork	X	X
Crystal		X
Delrin	X	X
Fabric	X	X
Glass		X
Leather	X	X
Marble		X
MDF	X	X
Melamine	X	X
Mirror		X
Mylar	X	X
Painted Metals		X
Paper	X	X
Plywood	X	X
Polycarbonate		X
Pressboard	X	X
Rubber	X	X
Slate		X
Stainless Steel		X
Tile		X
Titanium*		X
Twill	X	X
Veneer	X	X
Wood	X	X

**Can be marked using Cermark*

Please Note: Lasering PVC or Vinyl with any CO₂ laser will release corrosive and toxic fumes and will VOID the warrantee!

Laser Safety Training

Laser generated aerosols

- More vets are using CO₂ lasers

<http://www.veterinarypracticenews.com/vet-dept/small-animal-dept/c02-lasers-the-four-keys-to-success.aspx>

Laser Safety Training

Laser generated aerosols

Viral Disease Transmitted by Laser-Generated Plume (Aerosol)

Jerome M. Garden, MD; M. Kerry O'Banion, MD, PhD; Abnoeal D. Bakus, PhD; Carl Olson, DVM, PhD, Copyright **2002** American Medical Association. All Rights Reserved.

Objective To evaluate the possibility of disease transmission through liberated plume from virally infected tissue that is exposed to the carbon dioxide laser.

Design Bovine papillomavirus–induced cutaneous fibropapillomas were exposed to the carbon dioxide laser. Laser settings were within the range of clinically used settings. The laser plume (aerosol) was suctioned and collected and then reinoculated onto the skin of calves.

Setting University laboratory research center.

Main Outcome Measures Laser plume viral content and postinoculation tumor growth were analyzed and documented.

Results Collected laser plume contained papillomavirus DNA in all tested laser settings. The viral DNA was most likely encapsulated. Tumors developed at laser plume–inoculated sites for all laser parameter settings. Histological and biochemical analyses revealed that these tumors were infected with the same virus type as present in the laser plume.

Conclusions : Laser plume has been shown, for the first time to our knowledge, to actually transmit disease. Strict care must be maintained by the laser practitioner to minimize potential health risks, especially when treating viral-induced lesions or patients with viral disease.

Laser Safety Training

Any Laser Injury

If you have or suspect a laser eye injury:

- Call 5-2121 or 911 immediately
- Tell the operator that you need to be transported to the hospital
- Tell the operator to inform the ambulance crew that you have a laser eye injury.

If you feel ill and suspect an inhalation of a laser generated aerosol:

- Go to UHS and specify that the cause may be a laser generated aerosol
- Have information on the material that was burned or being cut by the laser

If you have or suspect a laser burn to the skin:

- Go to UHS if the burn is minor
- Call 5-2121 or 911 if the burn is major or if there is bleeding